INCOSE International Symposium
Philadelphia, PA
June 24-27, 2013

A Lean Approach to Improving SE Visibility in Large Operational Systems Evolution

Richard Turner, Stevens Institute
Jo Ann Lane, Barry Boehm, Dan Ingold USC
Ray Madachy, Naval Postgraduate School

Key Organizations

SYSTEMS ENGINEERING
Research Center
www.SERCuarc.org

Lean Systems Society
www.leansystemssociety.org

AGILE DEFENSE ADOPTION PROPONENTS TEAM
http://www.afei.org/workinggroups/adapt

Agile/Lean Community Connections

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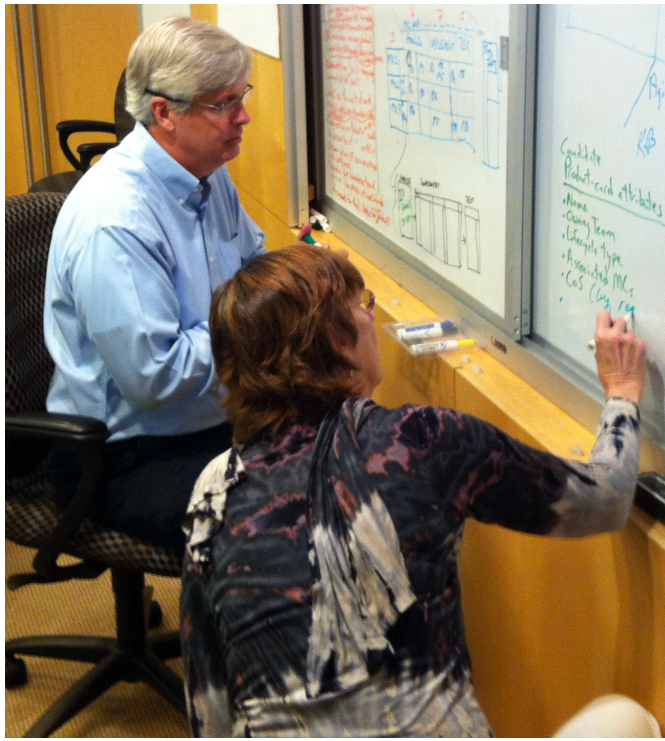
Industry Working Group

- David Anderson (David J. Anderson and Associates)
- Jabe Bloom (The Library Corporation) ■
- Hillel Glazer (Entinex) ■❖
- Curtis Hibbs (Boeing) ■◆★
- Suzette Johnson (Northrop Grumman) ✚◆★
- Larry Maccherone (Rally Development) ■
- Don Reinertsen (Reinertsen & Associates) ■
- David Rico (Boeing) ◆✚★
- Garry Roedler (Lockheed Martin) ◆❖
- Karl Scotland (Rally Software, UK) ■
- Alan Shalloway (NetObjectives) ■★
- Neil Shirk (Lockheed Martin) ◆❖
- Neil Siegel (Northrop Grumman) ◆❖
- James Sutton (Jubata Group) ■❖

★ AFEI-ADAPT
❖INCOSE
■ LSS
◆NDIA
✚ PMI



Target Environment for This Research

- Systems engineering where rapid response software-driven development projects incrementally evolve capabilities of existing systems or SOSs
  - C4ISR
  - Intelligence community
  - Hospital systems
  - Platform-based systems

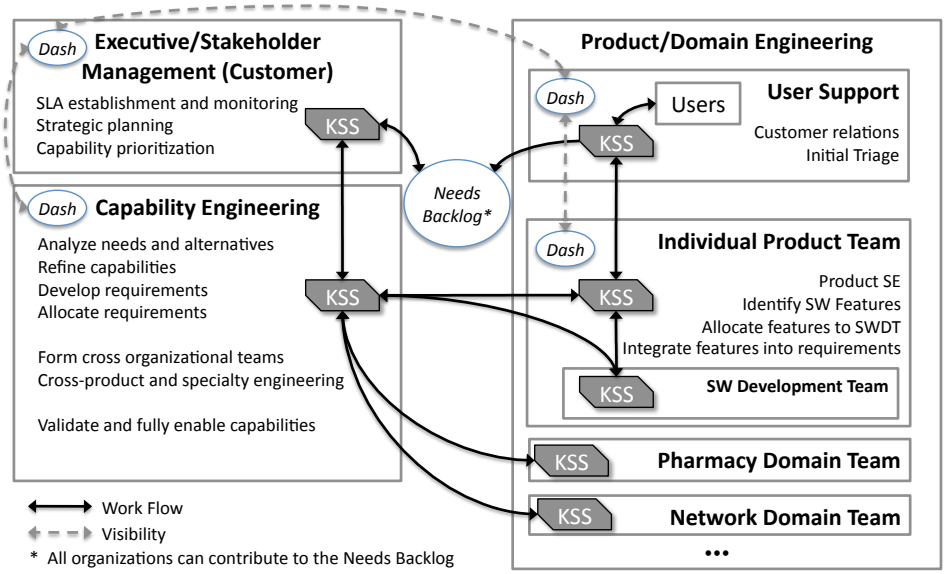
Problems and Symptoms

- Concurrent operational environments can overwhelm traditional governance methods
  - Stovepipes abound
  - Cowboy/hero engineering
  - Unscalable or unsupportable capabilities delivered
- Poor management visibility
  - IMS issues
  - Poor prediction of capability availability
  - Overloaded product teams
- SE disengaged from SW Engineering
  - Lack of SE responsiveness to product team requests
  - Product teams see SE as a barrier rather than an enabler

Goals (Desires)

- Better visibility and coordination managing multiple concurrent development projects
- More flexibility while retaining predictability
- More effective integration/use of scarce SE resources
- Increased project and enterprise value delivered earlier
- Less blocking of product team tasks waiting for SE response
- Lower governance overhead

Our Concept: A Multi-level Network of Kanban Scheduling Systems

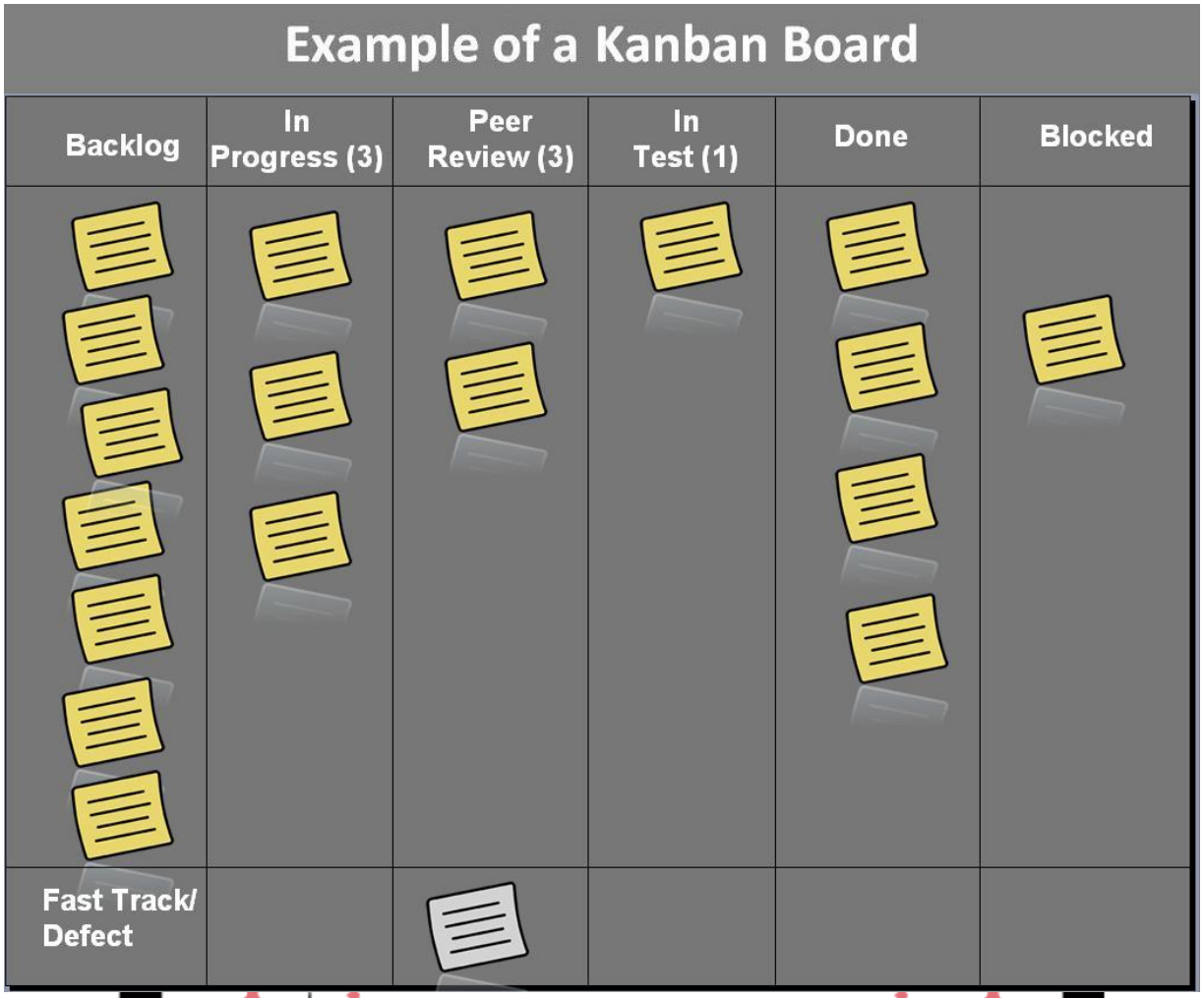


- Pull (kanban) scheduling
  - Value-based selection
  - Limited WIP
  - Classes of Service
- SE as a Service
  - Scarce resource-driven
  - Collaborative/Negotiated
- Integrated work and data flow
- Information radiators at all levels

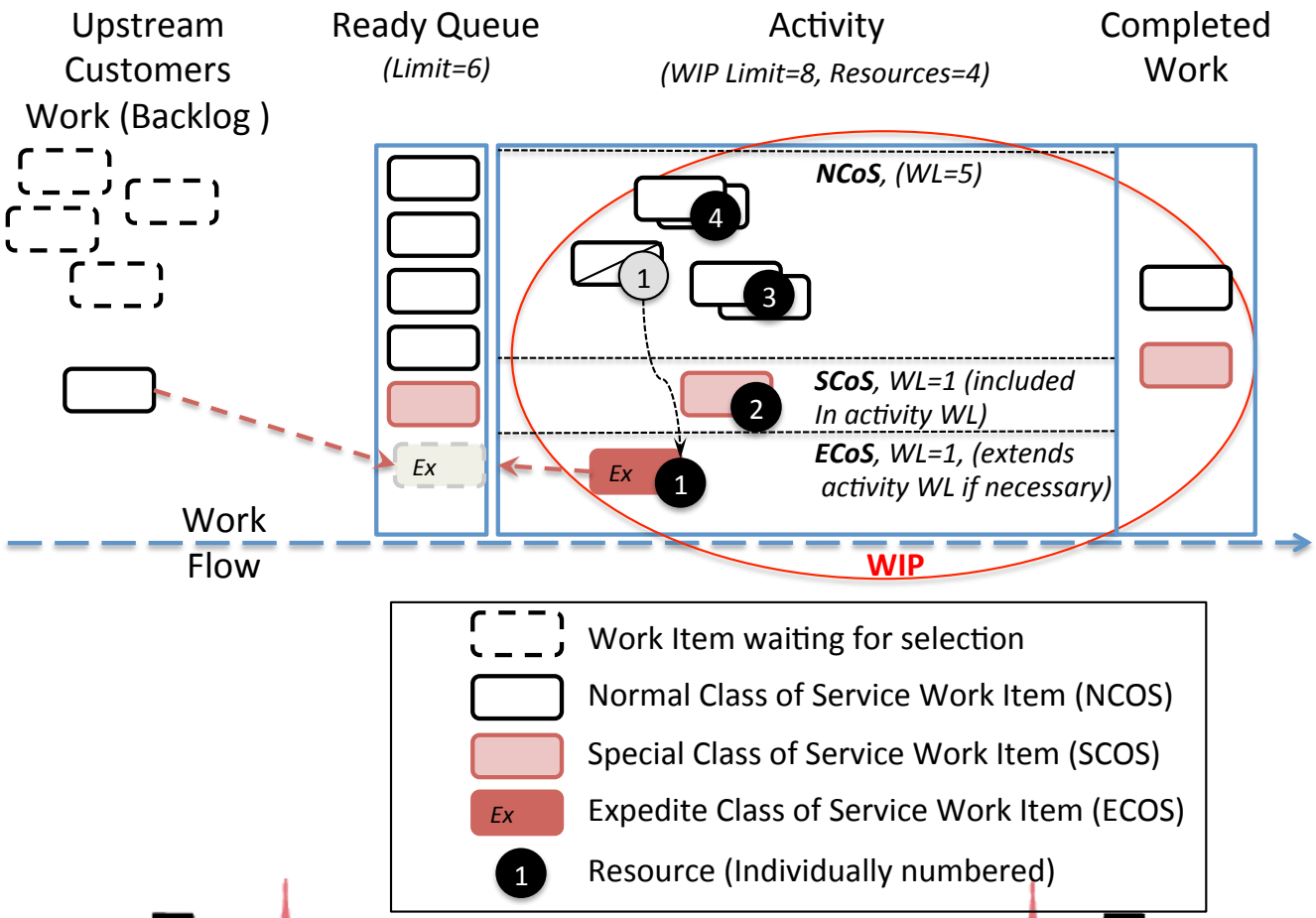
Kanban Systems

- Smooth flow by balancing work with resource capability
  - Increase visibility and communication
  - Right conversations, right people, right time
- Includes value-based selection and limiting work in progress (WIP) according to capacity
- On-demand or “pull” system
  - Work is pulled into the activity as capacity is available rather than “pushed” via a schedule
- Components of production in thoughtwork are ideas and information

A Kanban Board



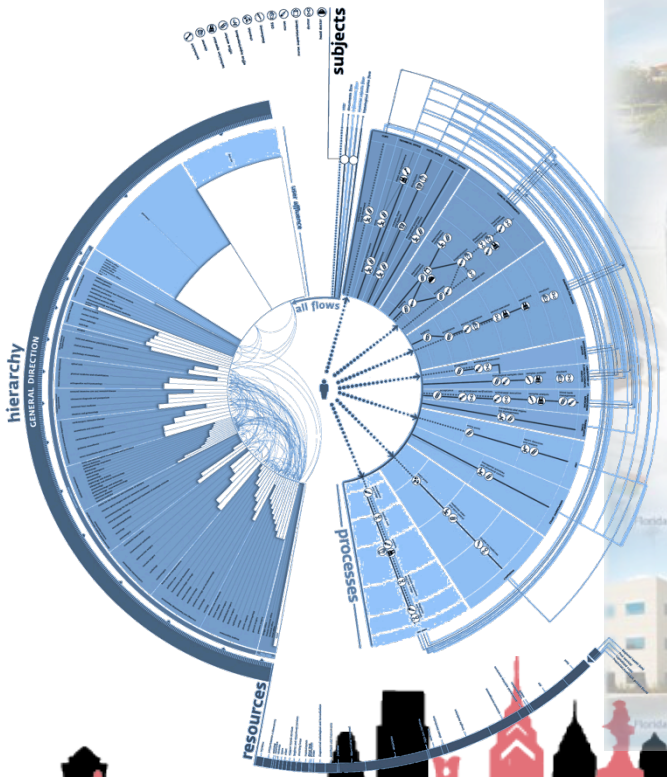
A Generic Kanban-based Scheduling System



Value/Priority for Servicing

- Maintaining prioritization across multiple stakeholders is resource-intensive and can cause delay
- Kanban forces stakeholders to agree only about what enters the kanban system queue next
- Stakeholders include customers/users, projects, executive management, and higher level systems engineering management
  - Negotiations with disparate levels of authority are difficult
  - Value functions consider inputs from all customers and help calculate value according to explicit policy
  - Service Level Agreements and Classes of Service help

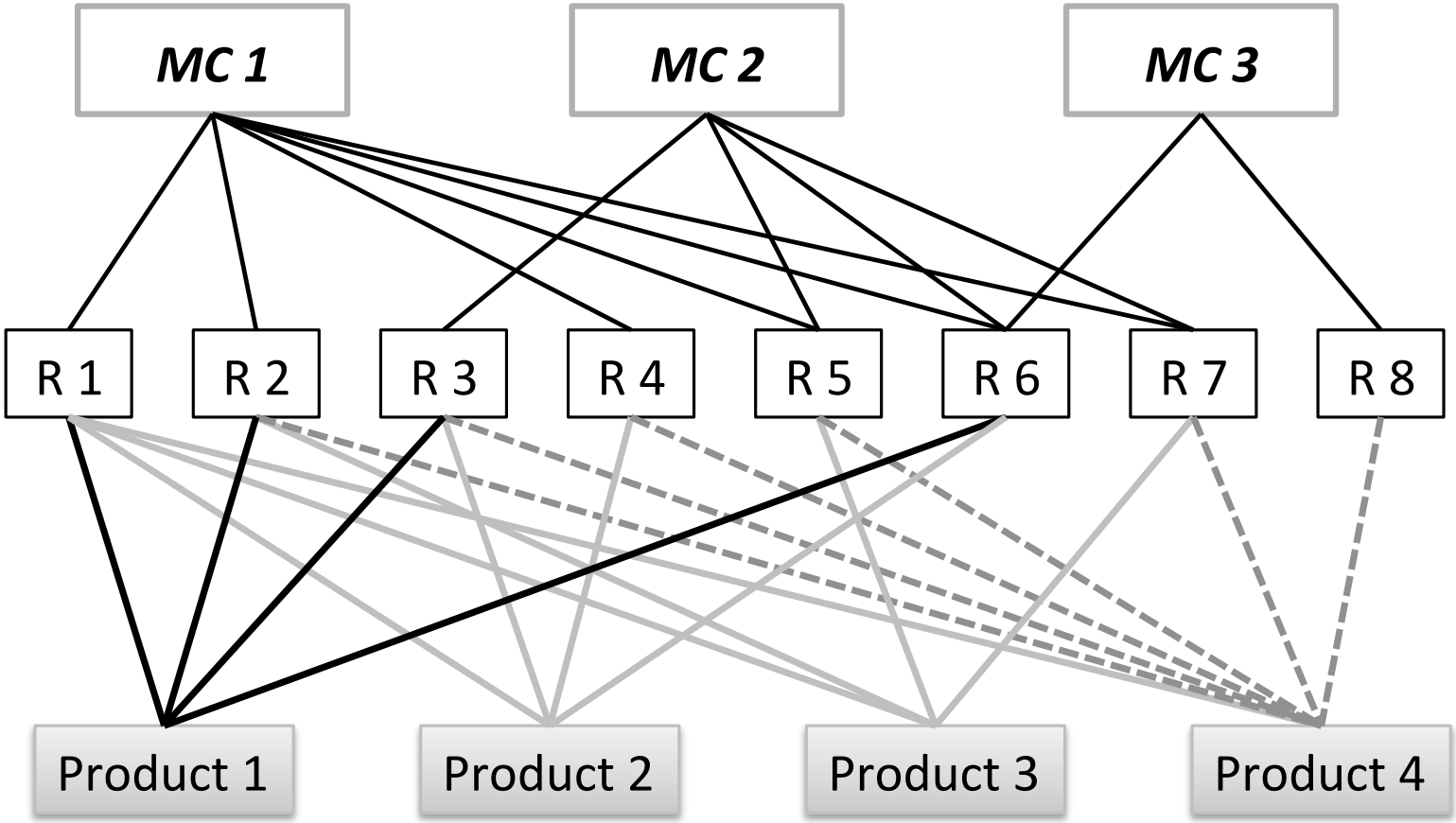
An Example Implementation in a Healthcare System of Systems



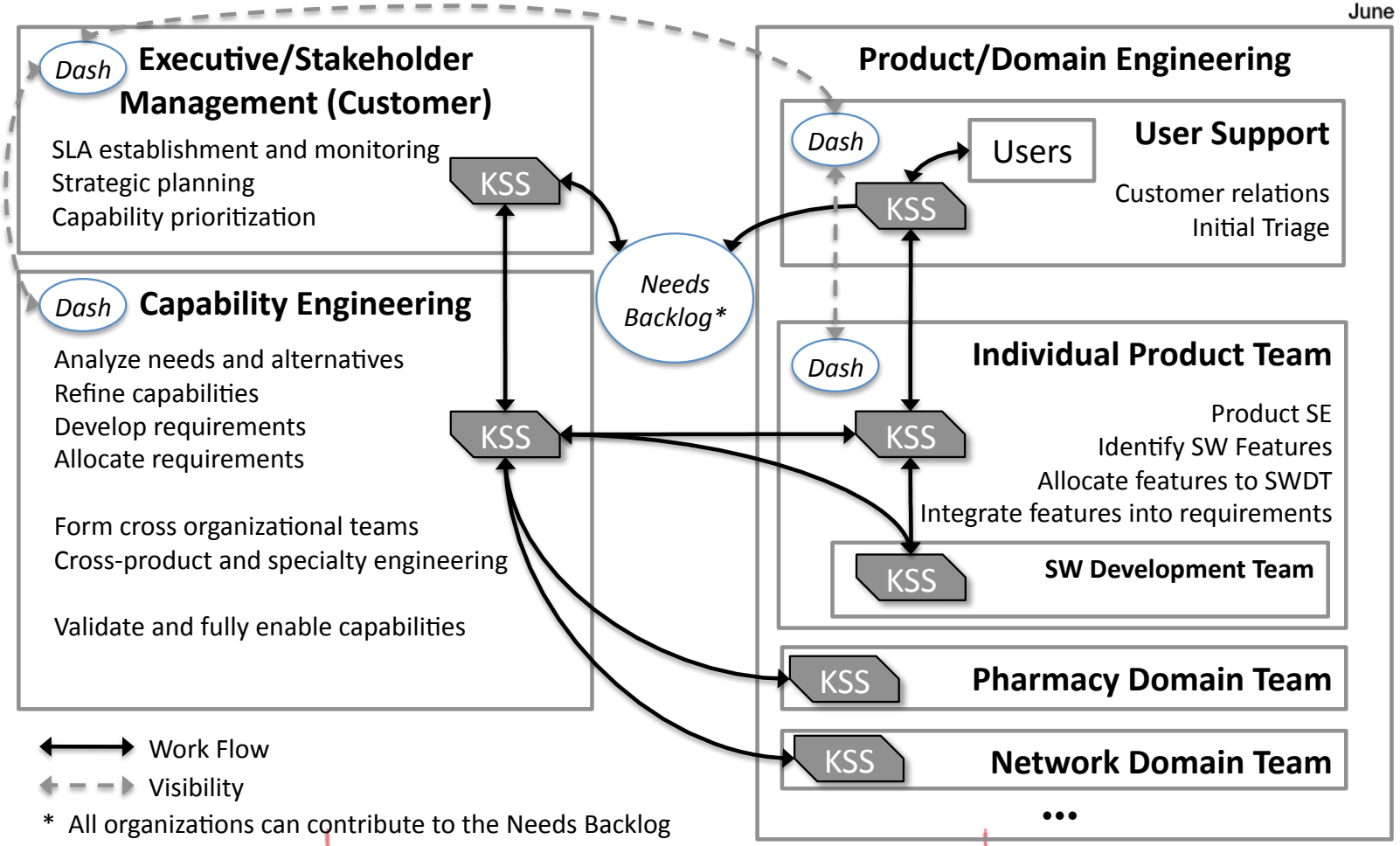
Healthcare SoS

- Custom software SoS constituent systems include patient management, pharmacy, laboratory, radiology, and telemetry
- Systems share a single database for all patients and personnel related to a given health care site
- Interfaces to other health care systems are maintained.
  - Custom legacy systems, COTS products, and medical devices
- The health care system's primary goal is to
  - support patient health care delivery
  - support coordination across a variety of health care providers
- Key overarching requirements are to ensure patient-safety and to protect patient information

Information/work Structure



Proposed KSS Network Structure



What Information is needed?

- How do we improve visibility? How do we support decisions?
- These sound like metrics questions.
  - Apply Goal-Question-Metric
  - Kanban systems generate inherent metrics
  - Re-purpose as Goal-Question-Kanban (metrics inherent to kanban)
  - Vic Basili, Dave Weiss, Dieter Rombach and Carolyn Seaman forgive us!
- Applied G-Q-K at each level of the architecture to understand the data needed
- Used this analysis as the basis to build the KSSs and Dashboards
- This was harder than it looked - we're still refining it

Classes of Service

CoS	Description
Critical Expedite	Safety, security, or other emergency work items. Disruptive: requires necessary resources to stop current work and complete it.
Important	Very high priority work items such that this work takes priority over other work in the ready queue. Not Disruptive.
Date Certain	Work items that must be completed by a specific date or there will be significant consequences.
Standard	The normal CoS for the development organizations work.
Background	Work that must go on but is usually not time critical. It includes things like architectural enhancements, low-level technical debt, or research and environmental scanning

Executive/Stakeholder Management KSS

- Determines which proposed capabilities (or enhancements) are approved to develop
- Assesses the value of the capability against its expected cost and schedule to develop.
- Tracks status by development state of approved but “not fully deployed” capabilities – WIP
- Informs decisions on organizational strategy, resource staffing, and funding priorities.

Executive/Stakeholder Management Dashboard

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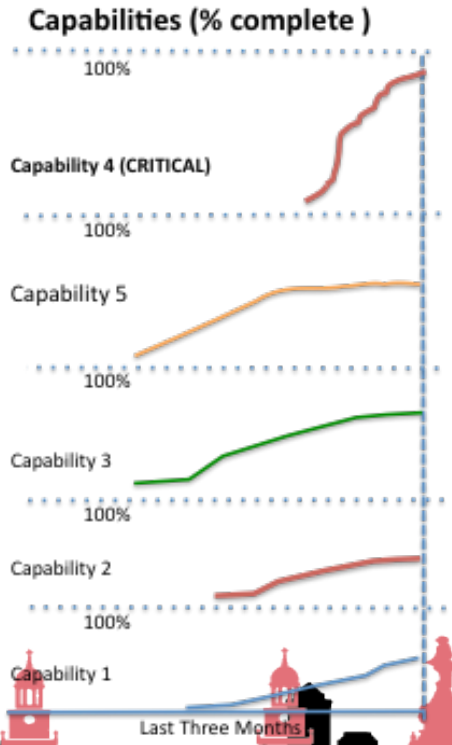
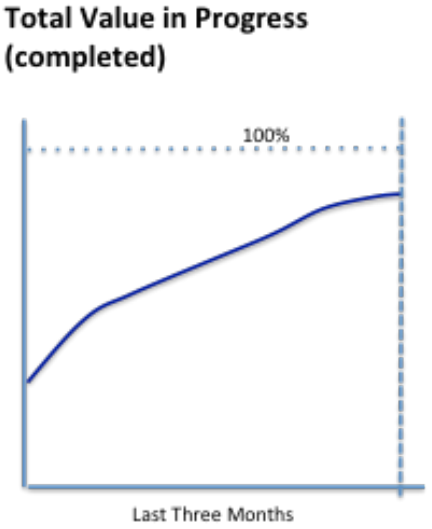
ESM Dashboard Capabilities in Progress	CoS	Value	Total # of Requirements	# Requirements Completed		% Value completed	# Requirements in Progress	% Value in Progress	% Requirements with work items blocked	Expected Completion
				Last Month	This Month					
Capability 1										
Capability 2										
Capability 3										
Capability 4 (CRITICAL)										
Capability 5										

ESM Backlog	Items in backlog	
	CoS	Value
Capability 6		
Capability 7		
Capability 8		
Capability 9		
Capability 10		
Capability 11		
Capability 12		
Capability 13		





Capability Engineering KSS

- Represents all capability SE activities, including specialty SE support for PTs
- Creates capability descriptions incorporating needs identified/prioritized by ESM.
- Balances various SE resources (internal activities and cross-organizational teams).
- Architectural work + support to development, integration, V&V and product teams.

Capability Engineering Dashboard/Kanban

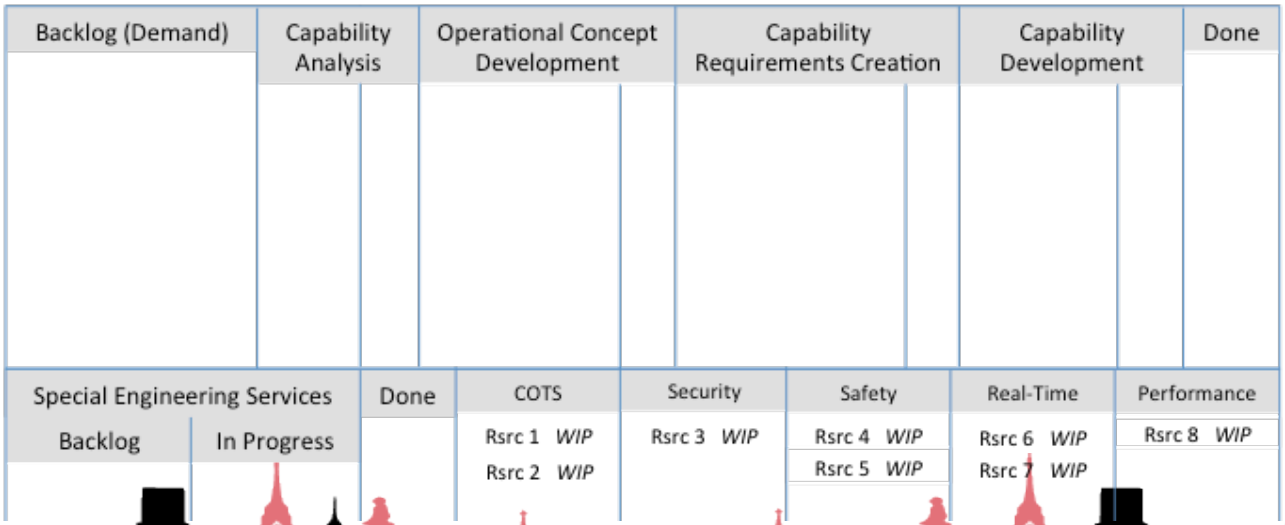
CE Dashboard			Work Items Completed		% Work Items Completed	% Value Completed	Number of work items blocked	Expected Completion
Key Requirements in Progress	CoS	Value	Last Month	This Month				
Requirement 1								
Requirement 2								
Requirement 3								
Requirement 4								
Requirement 5								
Requirement 6								
Requirement 7								
Requirement 8								
Requirement 9								
Requirement 10								
Requirement 11								
Requirement 12								
Requirement 13								
Requirement 14								
Requirement 15								

Average Work In Progress Ratio (Total Work items/Total Number of resources)

Percentage of demand queues beyond statistical upper limit

Average Deviation between Estimate and Actual Delivery for SW Team Requests

Special Eng.	Average WIP	Additional Information		
Specialty 1				
Specialty 2				
Specialty 3				
Specialty 4				
Specialty 5				
Specialty 6				
Specialty 7				

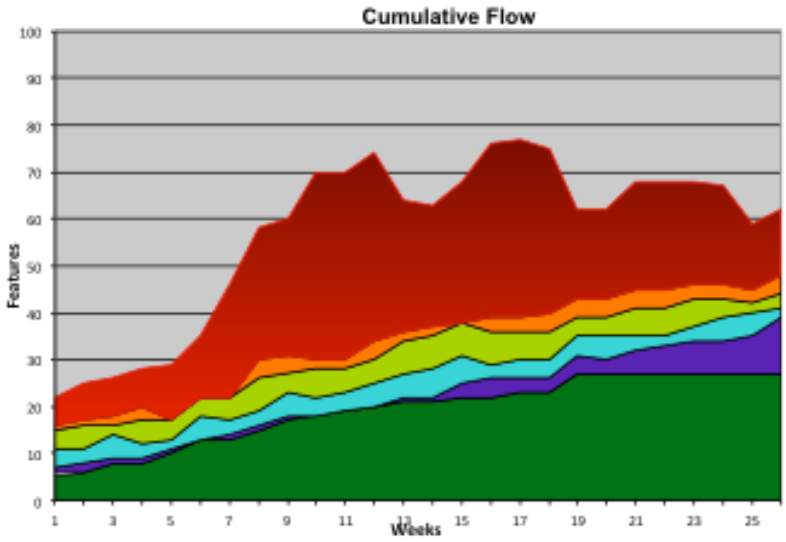


Product/Domain Engineering KSSs

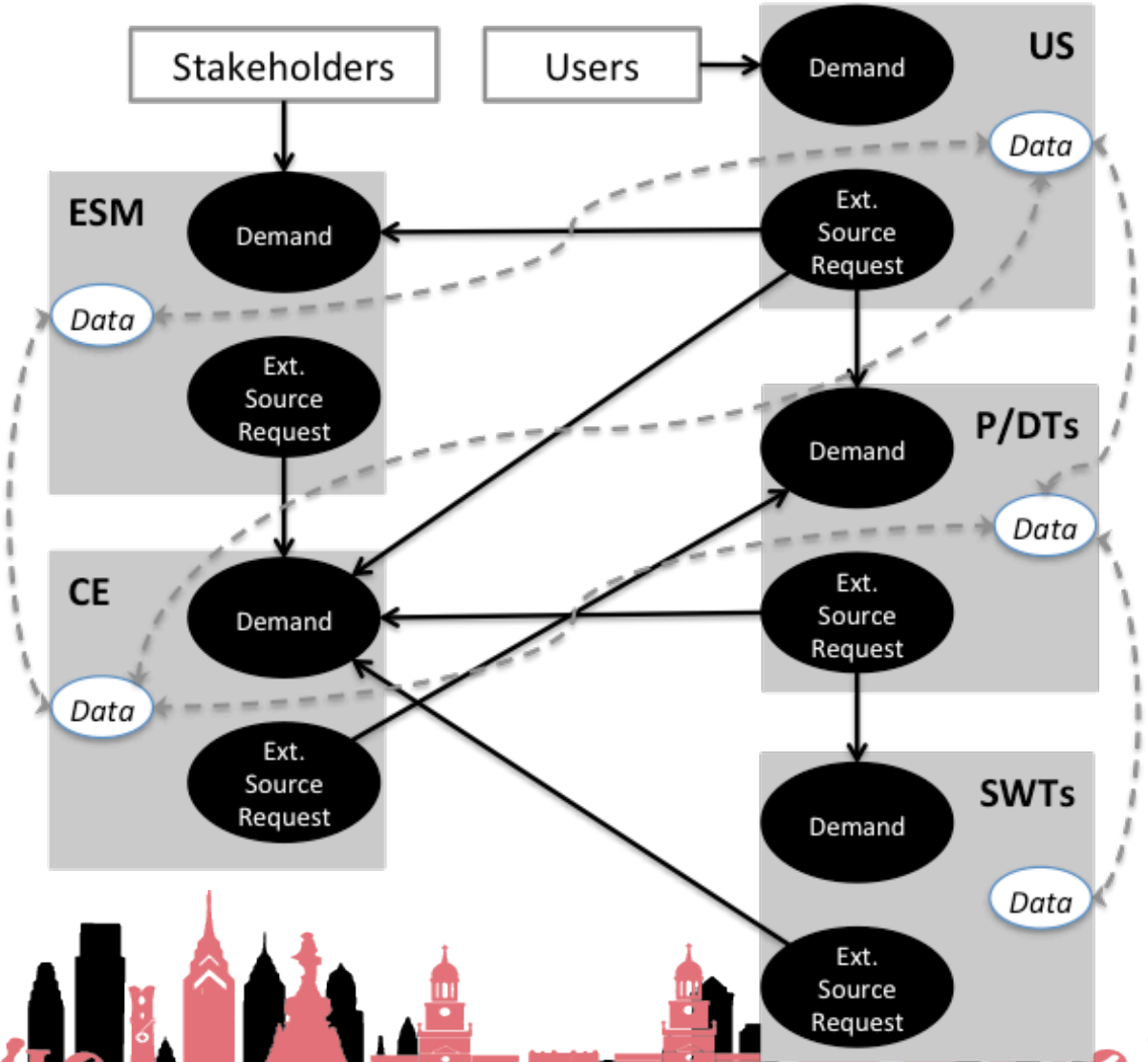
- Separate KSSs for each product or domain team in the enterprise
- Similar many software development organizations today, with the added requirement to perform systems engineering within the product or domain scope.
- Provide information to higher level KSSs and dashboards all the way to ESM level.

Product Team Dashboard

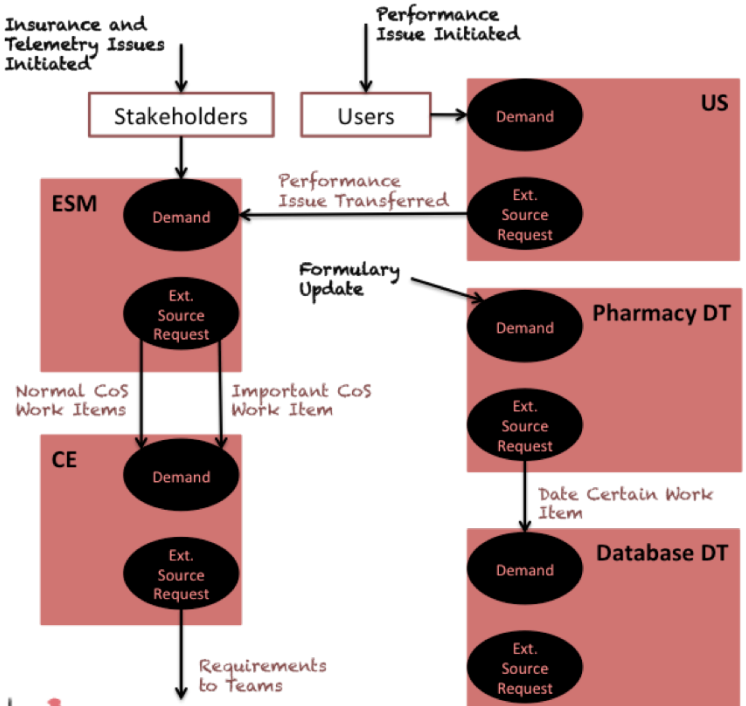
PT Dashboard Requirements in Progress	CoS	Value	% Features Completed	% Value Completed	# Features blocked	Expected Completion
Requirement 1						
Requirement 2						
Requirement 3						
Requirement 4						
Features in Progress	Cos	Value	Reqt	Sourced to	Blocked?	
Feature 1						
Feature 2						
Feature 3						
Feature 4						
Feature 5						
Feature 6						
Feature 7						
Feature 8						
Feature 9						
Feature 10						
Feature 11						



Flow among and between KSSs



Scenarios


Insurance and Telemetry Issues Initiated
Performance Issue Initiated
Stakeholders
Users
US
Demand
Ext. Source Request
Performance Issue Transferred
ESM
Demand
Ext. Source Request
Formulary Update
Pharmacy DT
Demand
Ext. Source Request
Normal CoS Work Items
Important CoS Work Item
CE
Demand
Ext. Source Request
Date Certain Work Item
Database DT
Demand
Ext. Source Request
Requirements to Teams

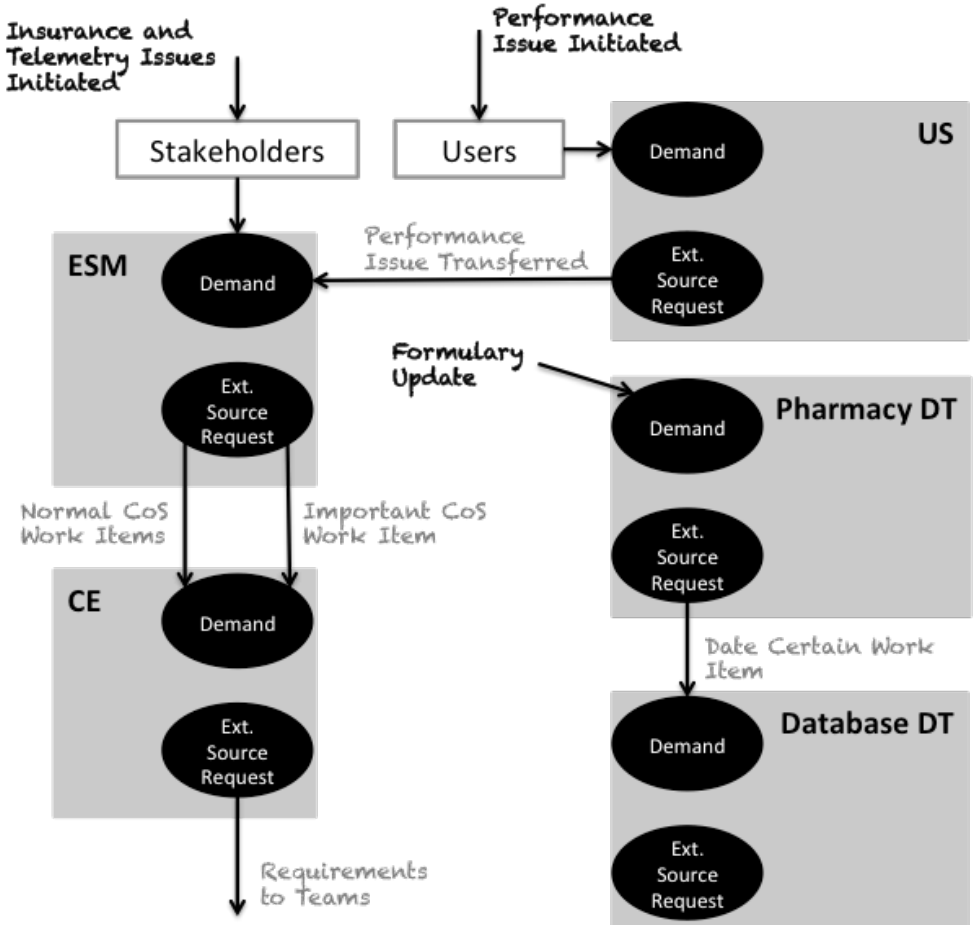
New Capabilities

- Interface to a new health insurance company
  - requires capture of additional information about patients, diagnoses, and physician orders
- Integrate and analyze information from multiple patient telemetry systems to improve diagnostic capabilities
  - COTS option: Identify and evaluate any COTS data fusion products that apply to the telemetry devices, select the "best" one, then integrate it into the enterprise
  - If no COTS available for all telemetry systems, two options:
    - Change non-compatible telemetry systems for more compatible ones
    -

Upgrade and Enhancement

- User response improvement
  - system response time is unacceptably slow and is potentially putting patient safety at risk
  - evaluate alternatives for improving the user response time and recommend one or more for funding.
- Periodic upgrade of pharmacy formulary information
  - Data on formularies and drug interactions updated quarterly (subscription service)
  - Updates analyzed against existing DB structures, any necessary updates to the data structures made, data structure updates tested and deployed, then populated with updated data

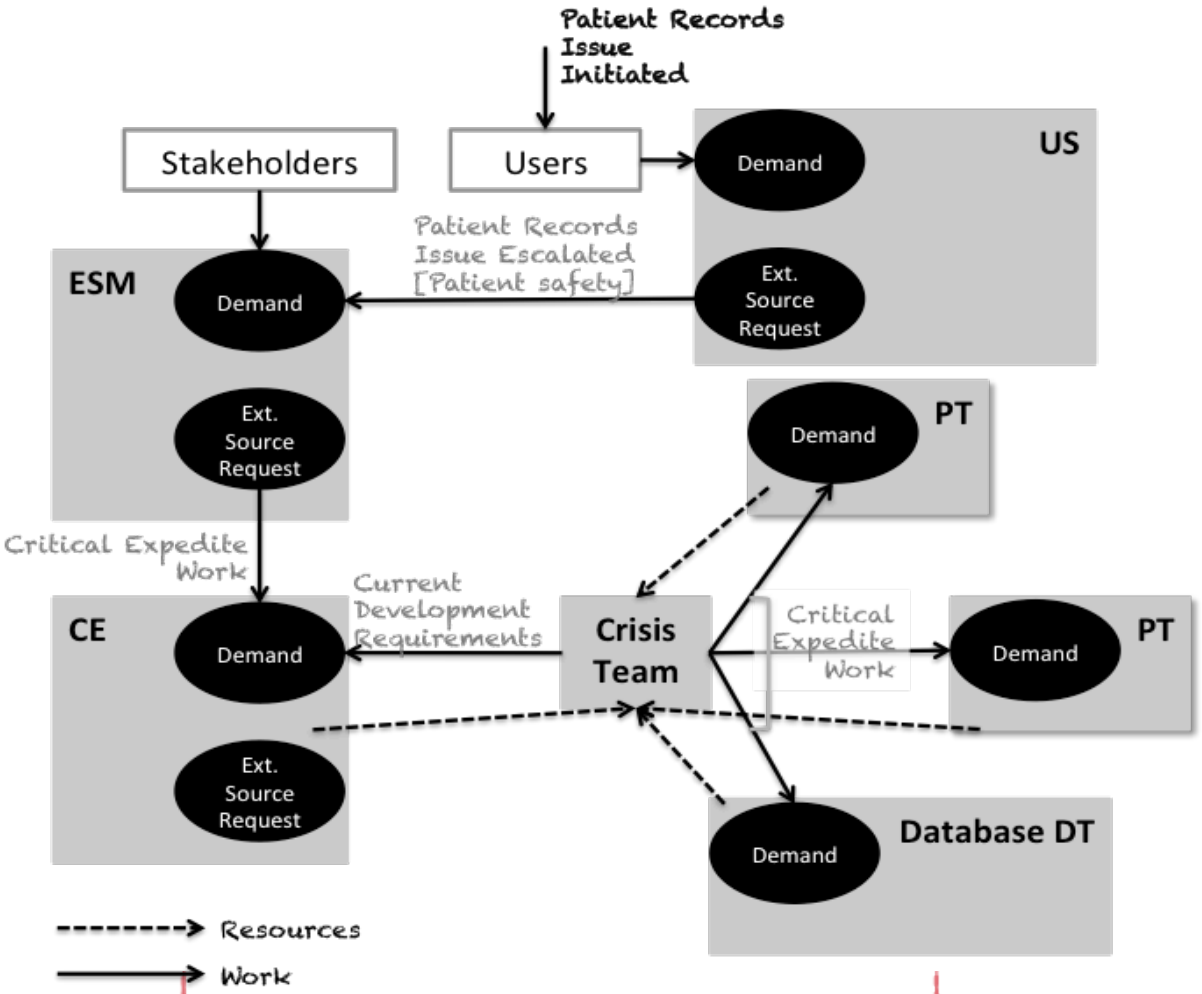
Normal Capability Development



Critical Issue: Interoperability Problem

- Feature to electronically send patient records to an external health care system was implemented, fully tested and seemed to function well during the first 30 days after deployment
- Late one night, a physician noticed that an important entry by external health care system not entered properly in the time log

Critical Task Operation



Results

- Provides
  - Aligned, unified view of work in progress and status of work
  - Predictability through measures easily SPC'd and projected
  - Value-based scheduling considers both system-wide and product priorities
  - Better use of C/SE resources; better servicing of product team SE needs
- Unlinks planning, scheduling, integration and deployment cadences
- Enhances decision making
- Supports continuous improvement
- Key Factor: Provides opportunity for right conversations, right people, right time

Questions?

Survey

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www.incose.org/symp2013/survey

Executive/Stakeholder Management KSS

Demand:			
Work sources	Needs backlog, Stakeholders, Critical Events, Strategic Plans		
Resources:			
Dedicated	IT Managers, CTO, …		
Shareable	None		
Sourced	CE		
Managed resource specialties	None		
Activities:			
Description	*WIP Limit*	*Resource Type*	*Cohesion*
Capability Analysis		Sourced (CE)	Interruptible
Capability Prioritization-CoS Assignment		Internal	Must complete
Capability Development Project		Sourced (CE)	Interruptible
Flow and Visibility:			
Additional CoS handled	None		
Additional CoS introduced	None		
Work Selection Value Adjustments			
Source-based	*CoS-based*	*Resource-based*	*Completion-based*
None	None	None	None

Capability Engineering KSS

Demand:				
Work sources	ESM, PDT, Internal			
KSS Resources:				
Dedicated	SoS SEs, Specialist SoS SEs (performance, algorithms, interface, security…)			
Shareable	Most			
Sourced	PDE Teams			
Managed resources	Specialty SoS SEs (performance, algorithms, interface, security…)			
Activities:				
Description		*WIP Limit*	*Resource Type*	*Cohesion*
Capability Analysis			X-discipline team	Interruptible
Operational Concept Development			Internal, X-discipline team	Interruptible
Capability Requirements Creation			Internal, X-discipline team	Interruptible
Capability Requirement Development			Sourced	Interruptible
Special Engineering Services			Internal (managed)	Interruptible
Flow and Visibility:				
Additional CoS handled	Software Service CoS: One of the issues identified was the amount of time product tasks were blocked waiting for SoSE (CE) support. This CoS is applied to all Specialty Engineering Services work items from PTs with significant software components. The CoS is not interruptible and provides a guaranteed WIP capacity. Resource reallocation is allowed to meet this CoS.			
Additional CoS introduced	None			
Work Selection Value Adjustments				
Source-based	*CoS-based*	*Resource-based*	*Completion-based*	
			Support to work associated with requirements or capabilities within 15% of completion are raised by 10% at selection cadence points	

Product/Domain Engineering KSSs

User Support KSS				
Demand:				
Work sources	User requests			
Resources:				
Dedicated	Help Desk Personnel, SW/System Engineers			
Shareable	None			
Sourced	PDE Teams, CE			
Managed resource specialties	SW/System Engineers may be handled as managed resource specialists			
Activities:				
Description		*WIP Limit*	*Resource Type*	*Cohesion*
Call Reception and triage			Internal	Must complete
Secondary ticket review			Internal	Interruptible
Ticket assignment			Internal	Interruptible
Flow and Visibility:				
Additional CoS handled	None			
Additional CoS introduced	None			
Work Selection Value Adjustments				
Source-based	*CoS-based*		*Resource-based*	*Completion-based*
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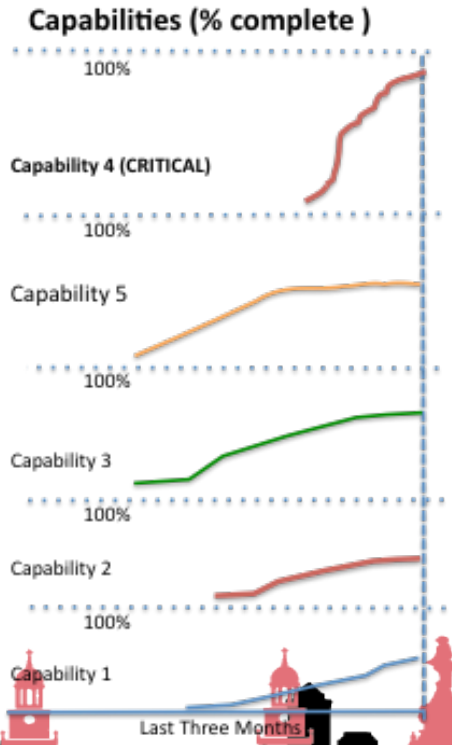

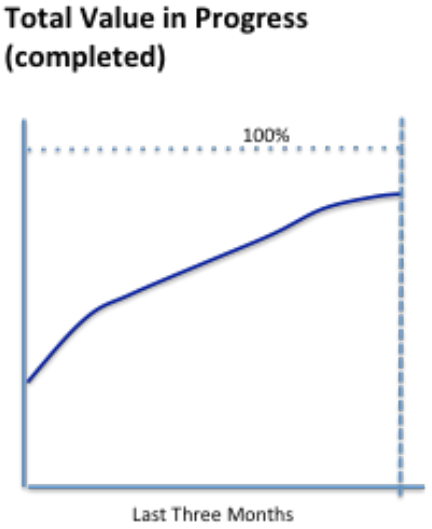

Capability Engineering Dashboard/Kanban

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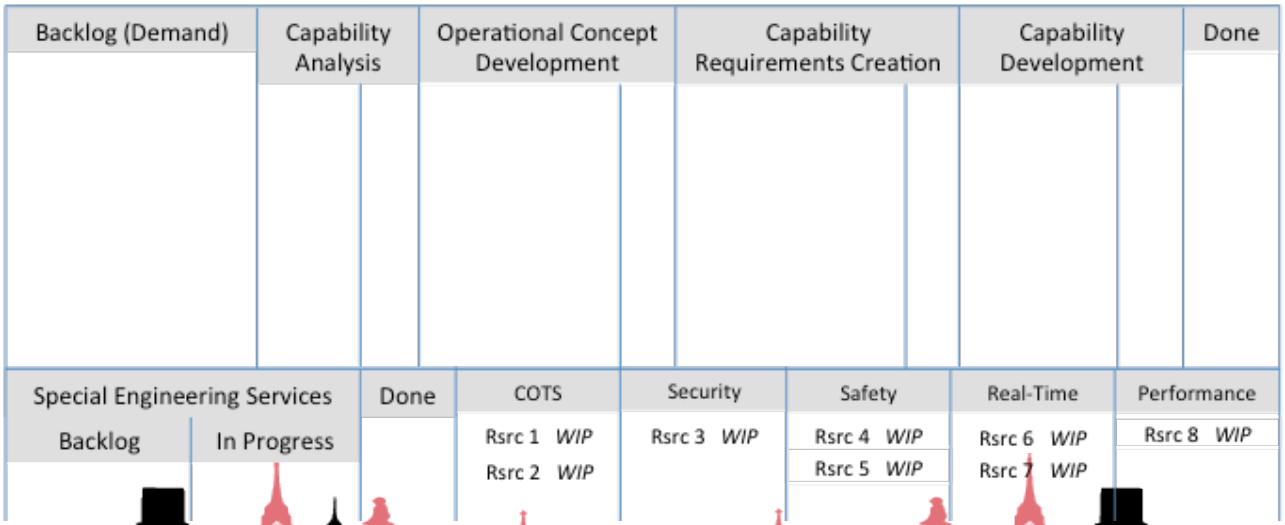

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